sistently placed much further to the east, and entirely outside the plains. One must also ask on what authority the Kickapoo are placed in southern Indiana, the Timuquana in southern Florida, the Arikara to the north of the Mandan, the Shasta in northeastern California and Nevada, the Quinaielt on the Oregon coast and the Tillamook in the Willamette Valley? These locations, so totally at variance with the accepted positions of these tribes, can only be due to carelessness in preparing the map, or to quite revolutionary new data which have come into Dr. Wissler's possession. Of the misprints noted, the following are the most important: p. 45, as*o*lepias for asclepias, apocy*r*um for apocy*n*um; p. 104, roo*m*s for roo*f*s; p. 182, Guat*o*vita for Guat*a*vita; p. 229, Ch*a*ponec for Ch*ia*p*a*nec; p. 273, north*east* for north*west;* p. 292, Hokan for Penutian; p. 231, Lecan for Changoan.

The great excellence and value of Dr. Wissler's book, however, must not be thought to be impugned by these stray criticisms. He has accomplished a difficult task with conspicuous success, has drawn for us the first adequate picture of the aborigines of the whole of America, and has given us a volume to which specialist and layman alike may turn with confidence that they will find in it the latest results of study in this field, admirably arranged and clearly stated. To all who are in any way interested in the original Americans, the book will be indispensable.

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SPECIAL ARTICLES

MASS MUTATION IN ZEA MAYS

THE principle of mass mutation, proposed by Bartlett on the ground of his researches on *Œnothera Reynoldsii* and *O. pratincola,* seems to me to be one of the most fertile discoveries made in the experimental study of the origin of new characters. In *O. Reynoldsii* the two first artificial generations were almost uniform, but in the third a splitting occurred, producing about 40 and 23 per cent. of two new types, which were called *semiata* and *debilis.* In *O. pratincola,* which in a number of strains is constant with some stray mutations, one strain produced in the third generation four different types, called *formosa, albicans, revoluta* and *stricta.* The total percentage of these amounted to about 75 per cent.

In order to explain this sudden appearance in such large numbers Bartlett assumes that the fundamental mutation occurred in only one of the two gametes in a generation preceding the one in which the diversity became manifest. In the next generation it was masked by the dominance of the character transmitted through the other gamete. Segregation then occurs in the following generation and it bears a certain degree of resemblance to Mendelian segregation. But whereas the law of Mendel applies to hybrids between different species, varieties or races, here the splitting occurs within a single experimental pure line. The law of probability holds good for both cases, but the starting points are different. Mutational segregation is directly concerned with the origin of a new character, but Mendelian segregation assumes the preexistence of all unit-characters involved. It should be remarked, however, that mass mutation is not necessarily limited to such cases, but may prove afterwards to embrace other types also.

It is now generally conceded that mutations take place ordinarily in the production of the sexual cells, some time before fecundation, probably at the time of synapsis. From this conception the conclusion directly follows that the copulation of two similarly mutated gametes must be rather rare. Far more frequent must be the instances in which a mutated sexual cell combines with a normal one. The first-named cases produced the full mutations, and the types with a doubled number of chromosomes, called *gigas,* are the clearest instances. Such forms have occurred in *Œnothera Lamarckiana, O. stenomeres, O. pratincola, O. grandiflora* and others. The individuals, due to the combination of mutated with non-mutated gametes may be called half mu-

tants. In nature, where, as a rule, mutations are very rare, the chance for the occurrence of full mutations is mostly too small, and stray novelties, found in the field, must generally have originated in the indirect way of half mutants followed by mass mutation. This would, at the same time, explain why they are so often met with in two or more individuals.

Half mutants may differ externally from the strain, which produced them, as *e. g.*, in the case of *Œnothera rubrinervis,* or may fail to show such visible marks, as in that of *O. Lamarckiana gigas mut. nanella.* In both cases they will give rise to the full mutant in relatively large numbers in the second generation. The full mutant of the first instance is designated as *O. mut. deserens,* and that of the second is represented by dwarfs with the flowers, foliage and nuclei of *O. gigas.* They occur in about 20–30 and 15–18 per cent. among the offspring of the original half mutants.

In a strain of ordinary corn, which I cultivated for other purposes, an instance of mass mutation has occurred which evidently requires the same principle for its explanation. The mutants have been described under the name of *Zea Mays sterilis* and figured in Vol. I. of the *Botanisch Jaarboek* of the Society Dodonæa at Ghent in Belgium. They are devoid of all branches. No lateral stems, no ears, no ramifications of the spike and no male flowers are produced. The whole plant is a barren stem with a naked spill instead of an inflorescence. They are built in the same manner as the unbranched fir, *Pinus Abies aclada,* described and figured by *Schröter.*

I cultivated my strain after a simple method, sowing each year the seeds of a single ear, planting the seedlings on sufficient distances to insure a high degree of self-fertilization and eliminating the individuals produced by stray crosses by means of vigorous selection. No unbranched specimens occurred during the six first years. In the seventh generation, however, they appeared unexpectedly and in 40 specimens among 340. This indicated a percentage of 12, which is far higher than the ordinary mutability in *Linaria, Chrysanthemum, Œnothera* a. o. (mostly 1–2 per cent.). Besides these unbranched plants some intermediate forms were seen, with incompletely developed ears and spikes. I chose one of these for the continuation of the race and had, next year, a generation of 57 individuals eleven of which belonged to the new type. The percentage figure was 19, giving new proof of the occurrence of mass mutation.

If we assume a sexual cell of the fifth generation to have mutated into the unbranched character, and to have combined with a normal one, the sixth generation may have included a half mutant of the new type, which could not be discerned at the time, since it was wholly unexpected, but was chosen by chance. Segregating after the principle of Bartlett it could have produced 25 per cent. of sterile individuals, besides 50 per cent. of half mutants with more or less incomplete ramification. These would repeat the splitting in the following generations. Had I known that principle at the time, I would surely not have given up the culture, as I did.

In the production of other sterile varieties the principle of mass mutation must have played a similar rôle. They can not evolve through the slow accumulation of small useful deviations, and their chance of arising at once as full mutants must be very little. Double flowers of the petalomanous type are well-known instances. I once found such a mutation of *Ranunculus arvensis* in a meadow, and the corresponding variety of *Caltha palustris* is cultivated in gardens, where it propagated in the vegetative way.

Yellow seedlings, which die after unfolding their seed-leaves, are another instance, and for these the mutational percentages are easily ascertained. They are often high enough to give proof of the presence of mass mutation. I found 25 per cent. for *Linaria vulgaris,* 15–30 per cent. for *Papaver Rhœas,* 10–15 per cent. for *Scrophularia nodosa,* 9–13 per cent. for *Clarkia pulchella* and about 10 per cent. in some other instances.

Mass mutation must be quite common in

nature. It is probably the ordinary way in which white-flowered, hairless and spineless varieties and so many analogous novelties are produced in the field and in horticulture. The experimental instances seem quite sufficient and broad enough to establish the principle, but as yet they belong almost to the retrogressive mutations. The claim that progressive changes are also due to sudden mutations still mainly rests on our theoretical conception of the evolution of organic life in general. But, fortunately, some experimental evidence is coming in of late for this point also.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

THE sixty-ninth meeting of Section E (Geology and Geography) of the American Association for the Advancement of Science was held in the auditorium of the new U. S. Bureau of Mines Building in Pittsburgh, Pa., on December 28 and 29. Professor George H. Perkins, vice-president of Section E, presided.

The general program, of which abstracts follow, was so full that each session far overran the usual time limit. Geological workers from the general Pittsburgh region contributed much to the success of the meetings.

The address of the retiring vice-president, Professor Rollin D. Salisbury, of the University of Chicago, upon the subject, "The educational value of geology," was given on the afternoon of December 28, and was printed in SCIENCE, April 5.

On the morning of December 29, a symposium entitled "Mineral resources and chemical industry" was held jointly with Section C. This was essentially a war-time session dealing with the peculiar problems now facing this country as the result of the war, the unusual demand for certain materials and products, and the necessity of relying upon the country's own reserves and industries for various materials formerly imported in large measure from sources not now available. The papers upon mineral resources described in detail the special efforts now being made by the U. S. Geological Survey and the U. S. Bureau of Mines to solve the problem of supplying the country with the necessary fuels, potash salts and metals (such as tungsten, chromium, nickel, cobalt, vanadium, manganese, etc.) which are required for the successful prosecution of the war. The papers on chemical industries portrayed some of the efforts put forth by the chemists in response to certain urgent needs and special situations developed by war conditions.

The Symposium comprised the following papers:

1. Introduction to the discussion of our mineral reserves under war conditions: David White.
2. Coal, coke and tar distillation: S. W. Parr.
3. The bearing of the oil industry on the war: C. H. Beal.
4. Glassware, with special reference to chemical glassware: S. R. Scholes.
5. Potash production in the United States: W. B. Hicks.
6. Research in chemistry and metallurgy as applied to non-ferrous metals: C. H. Fulton.
7. Domestic resources of ferro-alloy ores: D. F. Hewett.

These papers will be published in another number of SCIENCE.

Dr. David White, of the U. S. Geological Survey, was elected vice-president of the association and chairman of Section E for the coming year; Dr. Wallace W. Atwood, of Harvard University, member of the council; Dr. George F. Kunz, of New York, member of the General Committee; Dr. George F. Kay, of the University of Iowa, member of the sectional committee to serve one year in place of Dr. David White, resigned, and Dr. L. C. Glenn, of Vanderbilt University, member of the sectional committee for five years. To represent Section E at the celebration in honor of the one hundred and seventy-fifth anniversary of the birth of Abbé René Just Haüy, to be held at the American Museum of Natural History, New York City, on February 28, 1918, there were appointed by the chairman Dr. E. O. Hovey, Dr. C. P. Berkey and Dr. J. E. Woodman.

The titles and abstracts of the papers of the general program follow:

Glass sands: CHAS. R. FETTKE (will be printed in SCIENCE).

The Saltsburg sandstone as a building stone: S. B. BROWN.

The rapidity with which the Saltsburg sandstone gained favor may be seen from the number of important structures in which it has been used during the last six years. A few of these are the following: The Cabin John bridge at Washington City, some interior work in the Grand Central Rail-